



Web Service User Guide

The purpose of this document is to provide a guide for data users wanting to find and use web service layers as data providers have embraced usage of web services as data servicing points. These resources enable users to access and consume frequently updated data and metadata online or in desktop applications without needing to download data that takes up redundant storage space and may become quickly outdated. This sheet provides references and guidance for users to access and utilize these layers and their metadata in ArcGIS Pro, ArcMap, ArcGIS Online, and using the HIFLD Open web site (<https://hifld-geoplatform.opendata.arcgis.com/>).

The most common types of web services used are map services and feature services. Map services permit users to view georeferenced images and metadata within web-based or desktop maps but do not permit any data editing/manipulation or querying. Feature services allow features to be queried, attribute tables to be accessed, geoprocessing operations - and with permissions set by the data provider - dynamic feature editing, creation, and deletion. Feature services require more server and client resources as all attribute data is accessed when querying the service.

ArcGIS also permits adding Open Geospatial Consortium, Inc. (OGC) Web Map Service (WMS) and Web Feature Service (WFS) formats as an additional access method in ArcGIS Map and Feature Services if desired. These service capabilities function similarly to their corresponding ArcGIS map and feature services under a different standard protocol developed by the OGC. These services can be used in all ArcGIS access methods, barring in ArcMap without the *Data Interoperability* extension license.

	Map	Feature
Automatic data discovery	✓	✓
Common user endpoint	✓	✓
Usable in ArcGIS Online	✓	✓
Usable in ArcGIS Pro	✓	✓
Usable in ArcMap	✓	✓
Georeferenced	✓	✓
WMS/WFS Options	✓	✓
Export for local layer	✓*	✓
Images without geometry	✓	
Low Internet and Resource Usage	✓	
Permits querying		✓
View attribute table		✓
Geoprocessing		✓

*Exportable as a layer file (.lyrx) or layer package formats (lpk) only; data is linked to service and is not editable.

Figure 1: A table showing shared and unique capabilities of web service types. Permissions can be set for specific user groups for both types of services. General capabilities can also be set to enable or disable functionalities to fit organizational preferences.



Various functionalities are available in the primary types of web services and can be explored by right-clicking on the layer after being brought into ArcGIS software (Figure 2). The *Export Features* and *Attribute Table* capabilities of feature services or WFS formats are a key added functionality. In contrast, map services or WMS formats only allow the attribute table to be viewed in ArcGIS Online. The *Save As Layer File* capability is the closest match to the feature service's *Export Features* functionality, but it only makes an unchangeable copy of the map service as opposed to making an editable offline copy feature class or shapefile.

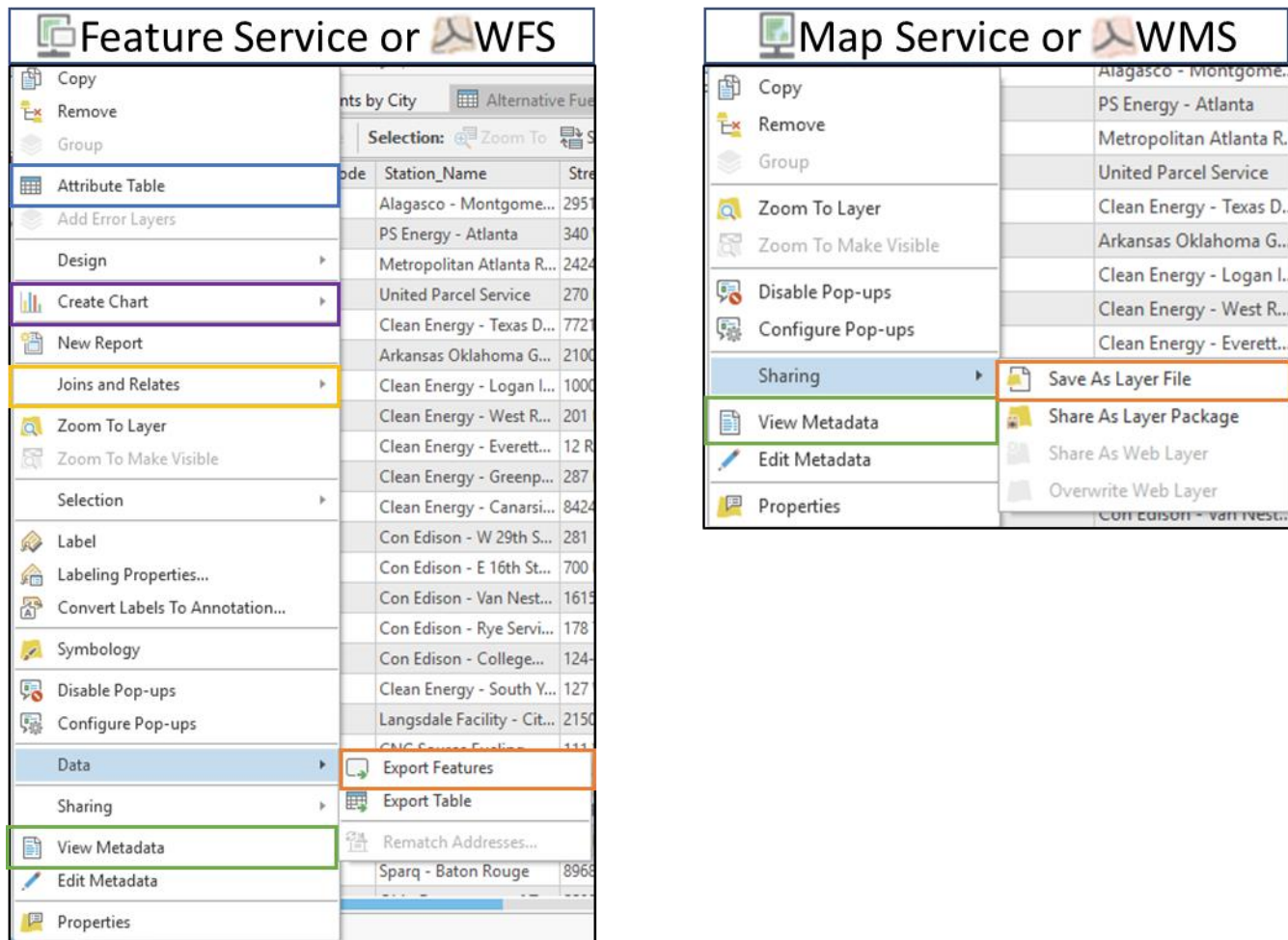


Figure 2: An example of functionalities available in Figure 1 accessed by right-clicking on (left) a Feature Service of WFS or (right) a Map Service or WMS. The symbols for each of these service types as found in the ArcGIS catalog are shown in their respective blocks. Significant functionalities and their approximate equivalent in the opposite service type are highlighted.



Accessing and Using Web Services

This section focuses on Esri ArcGIS software and data formats. Open source GIS software such as QGIS and service capabilities such as Mobile Data Access, Network Analysis, Web Coverage Services (WCS), and Schematics Servers are not focused on although they can be useful to certain organizations for particular purposes. ArcGIS Pro, ArcMap, ArcGIS Online, and HIFLD Open tutorials are outlined below.

ArcGIS Pro

This tutorial provides information and step-by-step instructions on using a variety of services and their associated metadata in ArcGIS Pro. ArcGIS Pro offers additional functionalities over ArcMap with native WMS and WFS compatibility. Additional functionalities built into ArcGIS Pro – such as more geoprocessing tools, enhanced data visualization, and improved performance – make this software very effective at managing and working with various types of web services. Bringing in a web service is a straightforward workflow and is outlined below – consider user purpose with the data for what type of service to import.

1) Determine the Representational State Transfer (REST) root server URL location that holds the service(s) desired. These are often indicated by the domain followed by 'arcgis/rest/services'. In this example, the United States Army Corps of Engineers (USACE) Inland Electronic Navigation Chart's (IENC) layer *Administration Areas* will be used. A map service with WMS and WFS capabilities are available.

2) In the ArcGIS Pro **Catalog** pane, navigate to **Favorites**, and select **Add Item** (Figure 3). If the user wants to import the web service as is, continue to step 3a. If capabilities similar to a Feature Service are desired but only Map Services are available, follow the workflow on step 3b to add a WFS.

3a) Select **New ArcGIS Server** and input the *base* server URL. This will add the entire server and all its contents to the catalog pane for browsing. Credentials are not required for this particular server.

3b) Select **New WFS Server** and input the *specific* WFS service URL. This URL is acquired by navigating to the target service online, and selecting **WFS** at the top from the MapServer page. This will add the specific service to the catalog pane. Note the default URL loaded may need to be truncated to match the required format. Credentials are not required for this particular server.

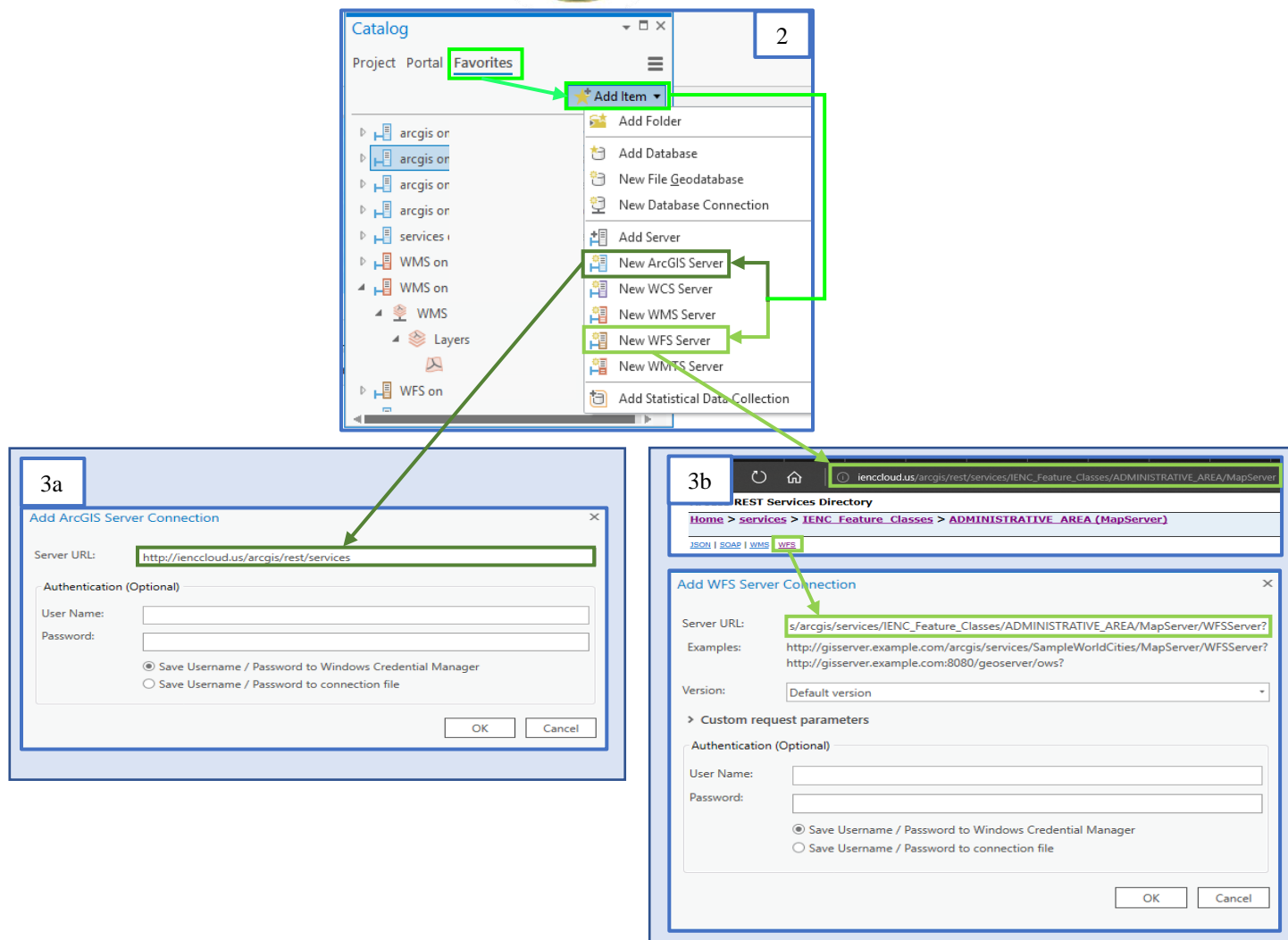


Figure 3: Workflow on how to add (a) New ArcGIS Server or (b) WFS Server (steps 2, 3a, 3b).

4) Upon selecting **OK**, ArcGIS Pro will attempt to connect to the server selected. Once connected, navigate to the desired service, right-click on it, and select **Add to Current Map** or **Add to New...** as desired.

5) The layer is now loaded into ArcGIS Pro and can be visualized on the map and seen in the **Contents** pane. Right-clicking on the layer in the **Contents** pane will open a list of capabilities found in Figure 2.



Viewing International Organization for Standardization (ISO) 19139 Metadata

Nearly all metadata in HIFLD Open layers can be displayed in ISO 19139-compliant format in ArcGIS Pro. The HIFLD Open Data site has adopted this format as an expected format as it is flexible, can apply to a broad range of geospatial data and applications, and is consistently represented in an Extensible Markup Language (XML) format.

Service metadata that is clearly available at the REST endpoint (e.g., ServiceURL/info/metadata) is sometimes not correctly translated into the **Catalog's Metadata** tab after selecting **View Metadata**. Note, viewing metadata directly from the REST endpoint in a browser is not ideal as it does not translate formatting – which can be done in ArcGIS software – but all content in the metadata is displayed as an Extensible Markup Language (XML) file. If properly formatted metadata is not originally accessible from the **View Metadata** functionality, attempt changing the metadata style to ISO 19139 to see if the metadata visualized is in the proper format (Figure 4).

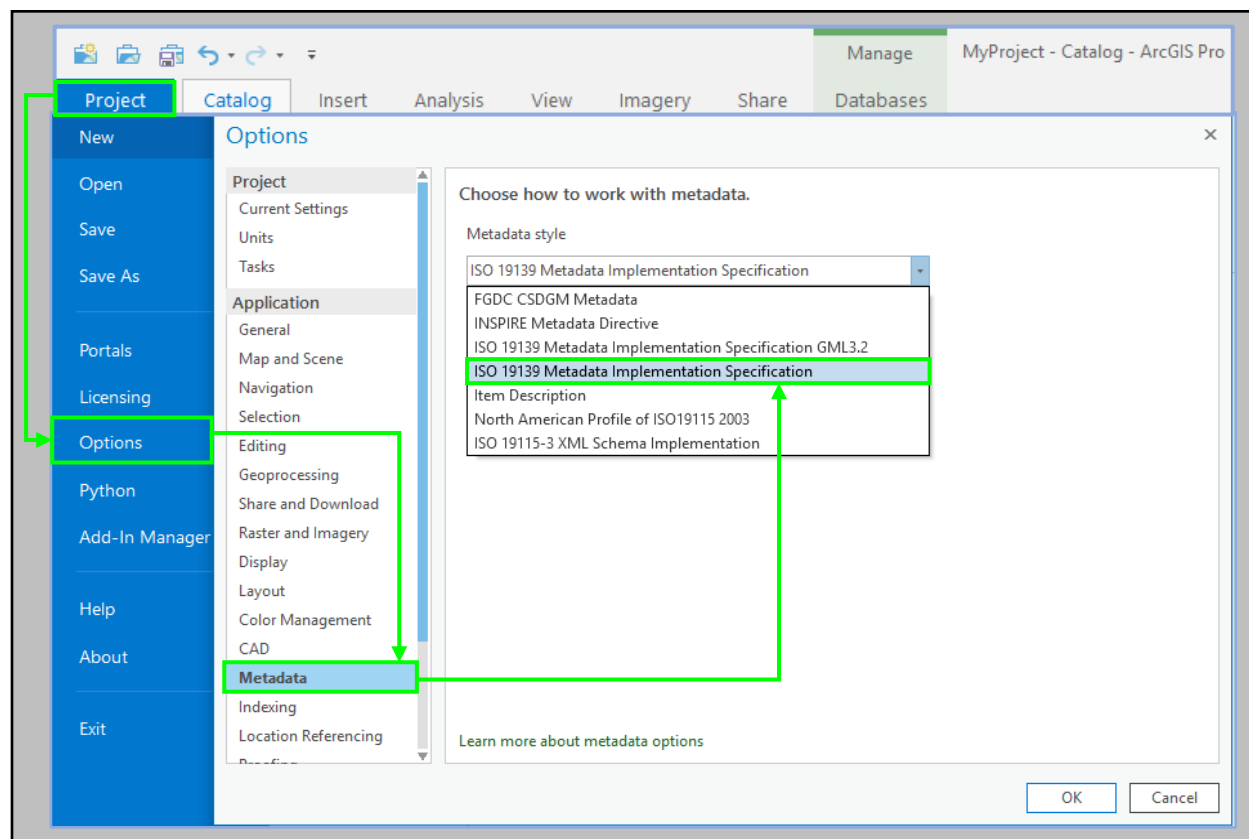


Figure 4: Workflow to change metadata style to ISO 19139, the most common HIFLD Open metadata format.



ArcMap

This tutorial provides information and step-by-step instructions on using a variety of services and their associated metadata in ArcMap. Though ArcGIS Pro is more advanced software, many users of HIFLD data are still utilizing ArcMap software. While the functionality of this client is not as robust and user friendly as ArcGIS Pro, web services are still easily imported and used in ArcMap. The workflow is very similar to that used in ArcGIS Pro, but the *Data Interoperability* extension license is required to use WFS (optional step 3b).

- 1) Determine the Representational State Transfer (REST) server URL location that holds the service desired. These are often indicated by the domain followed by 'arcgis/rest/services'. In this example, the USACE IENC's layer *Administration Areas* will be used. A map service with WMS and WFS capabilities are available.
- 2) In the **Catalog** pane, scroll down to **GIS Servers**. If the user wants to import the map service as is, continue to step 3a. If capabilities similar to a Feature Service are desired but only Map Services are available, follow the workflow on step 3b. Note that the *Data Interoperability Extension* license is needed to add a WFS in ArcMap.
- 3a) Select **Add ArcGIS Server** and select **Use GIS services** before hitting **Next**. Input the *base* server URL. This will add the entire server and all its contents to the catalog pane for browsing. Credentials are not required for this particular server.
- 3b) Select **Add WFS Server** and input the *specific* WFS service URL. This URL is acquired by navigating to the target service online, and selecting **WFS** at the top from the MapServer page. This will add the specific service to the catalog pane. Note, the default URL loaded may need to be truncated to match the required format. Credentials are not required for this particular server.

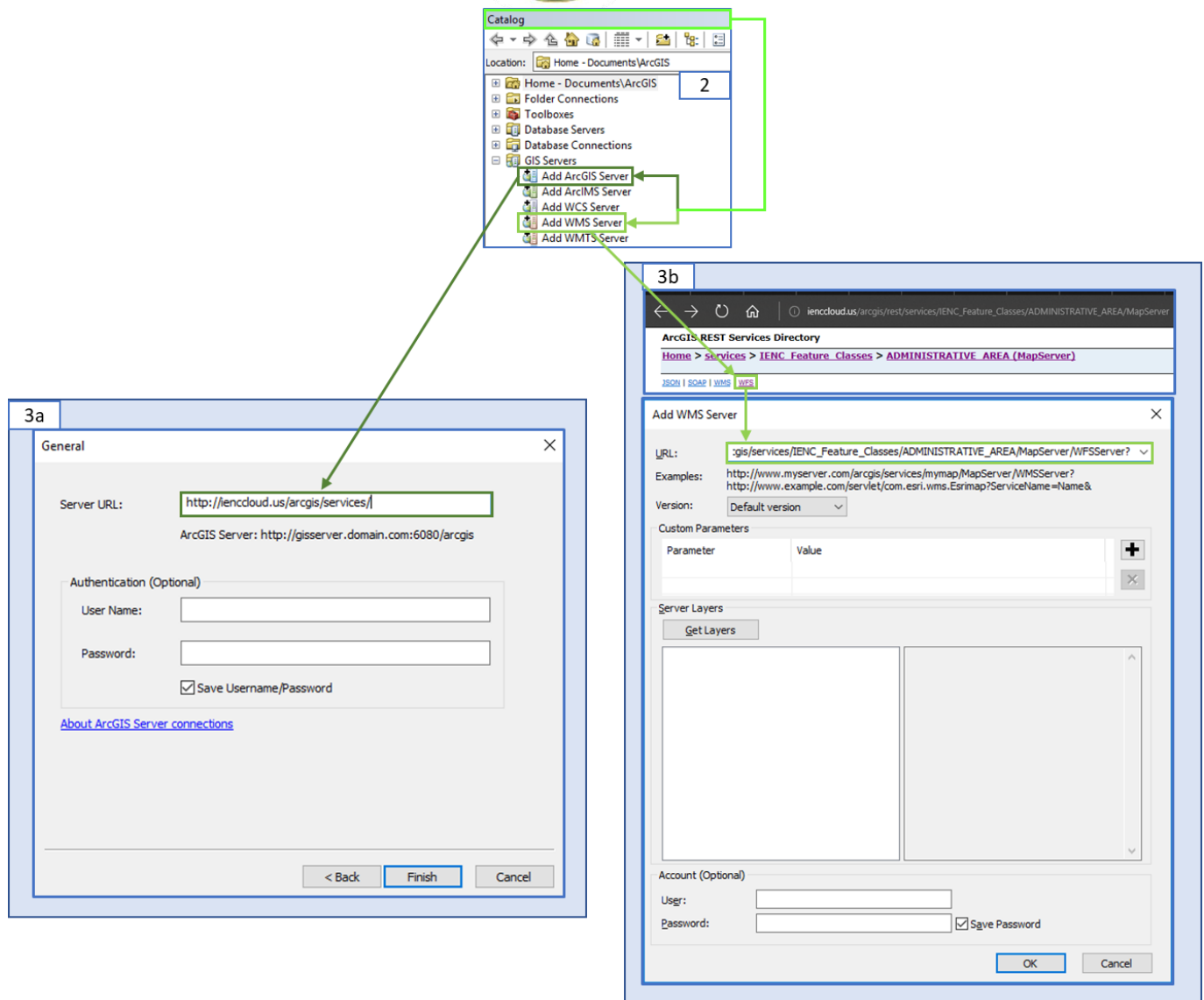


Figure 5: Workflow on how to add (a) New ArcGIS Server or (b) WFS Server (steps 2, 3a, 3b).

4) Upon selecting **Finish** or **OK**, ArcMap will attempt to connect to the server selected. Once connected, navigate to the desired service, right-click on it, and drag the desired service into the map area. The layer will be loaded into ArcMap. Right-clicking on the layer in the **Contents** pane will open a list of capabilities found in Figure 2.



ArcGIS Online and Portal

This brief tutorial provides information and step-by-step instructions on importing a variety of services and their associated metadata from ArcGIS Online, in apps, or custom organization portals such as the GeoPlatform Portal. When the REST endpoint of the target service is located, users may access the data from (A) an existing web map or app or (B) directly from the REST endpoint. In this example, the USACE IENC's layer *Administration Areas* will be used.

A) Create a blank web map or access an existing web map on ArcGIS Online's **Map** pane. A custom portal designed by an organization can also be used. Use the **Add Layer from Web** option to load the service from its REST endpoint (Figure 6). You may either add the entire service or feature layers using layer IDs (e.g., <https://Server/ServiceName/MapServer/0>) that are located at subdirectories of the service itself to web maps. ArcGIS Online can also add other service types such as **WMS/WFS OGC Web Service**, note that modification or truncation of the URL similar as outlined above in the **ArcMap** and **ArcGIS Pro** (step 3b) sections may be required for the service to be properly read.



Figure 6: Workflow A for bringing in a web service from an existing web map.



B) Access the REST endpoint and use hyperlinks to view the service in a variety of ways (Figure 7a). To load it into a web map, select [i] **ArcGIS Online Map Viewer**. Depending on data provider permissions, you may also load versions into [ii] ArcMap, ArcGIS Earth, ArcGIS Explorer, JavaScript, and [iii] Application Processing Interface (API) options.

To view metadata from this page, scroll to the bottom and select **Info**, then **Metadata** (Figure 7b,i). For more technical users, a variety of JavaScript Object Notation (JSON) and Hypertext Markup Language (HTML) queries can be run against layers to narrow selections and create exportable subsets from service REST endpoints regardless of service type (Figure 7b, ii).

Figure 7 consists of two screenshots, A and B, illustrating the REST endpoint page and the workflow for viewing root XML metadata online and querying data in JSON, HTML, or other formats.

Panel A: Shows the REST endpoint page for the service `IENC_Feature_Classes/ADMINISTRATIVE_AREA (MapServer)`. Key functionalities highlighted include:

- View In:** ArcGIS JavaScript, ArcGIS Online Map Viewer (highlighted with a green box and labeled 'i'), ArcGIS Earth, ArcMap, ArcGIS Explorer.
- View Footprint In:** ArcGIS Online Map Viewer (highlighted with a green box and labeled 'ii').
- Service Description:** A defined (and possibly named) administrative area. Distinction: land region; con
- Map Name:** Layers
- Legend**
- All Layers and Tables**
- Dynamic Legend**
- Dynamic All Layers**
- Layers:**
 - ADMINISTRATIVE_AREA (0)
- Description:**
- Copyright Text:** USACE IENC
- Spatial Reference:** 4326 (4326)
- Single Fused Map Cache:** false
- Initial Extent:**
 - XMin: -95.19028623499999
 - YMin: 29.014154750000067
 - XMax: -78.75524486499994
 - YMax: 43.43784425000005
 - Spatial Reference: 4326 (4326)

Panel B: Shows the workflow for viewing root XML metadata online and querying data in JSON, HTML, or other formats. Key steps highlighted include:

- Build Resources:** Info (highlighted with a green box and labeled 'i'), Dynamic Layer.
- Supported Operations:** Export Map, Identify, QueryDomains, Find, Return Updates, Generate KML.
- Info (IENC_Feature_Classes/ADMINISTRATIVE_AREA):**
 - Child Resources:** Iteminfo, Metadata (highlighted with a green box and labeled 'ii'), Thumbnail.
- XML Metadata:**

```
<?xml version="1.0"?>
<metadata xml:lang="en">
  <Esri>
    <CreateDate>20200521</CreateDate>
    <CreateTime>17164100</CreateTime>
    <ArcGISFormat>1.0</ArcGISFormat>
    <ArcGISStyle>ISO 19139 Metadata Implementation Specification</ArcGISStyle>
    <SyncOnce>TRUE</SyncOnce>
  </Esri>
  <dataInfo>
    <idPurp>The U.S. inland navigation system consists of 8,200 miles of rivers maintained by the Corps of Engineers in 22 states, and includes 276 lock chambers with a total lift of 6,100 feet. The highly adaptable and effective system of barge navigation moves over 625 million tons of commodities annually, which includes coal, petroleum products, various other raw materials, food and farm products, chemicals, and manufactured goods. The shallow draft waterways have many unique characteristics and difficulties over coastal harbor and ocean navigation; river levels can change by over 30 feet in a seasonal cycle, the navigation channel can shift significantly within the river banks, and shifting yet ever present river currents pose constant challenges in these confined waterways. Electronic chart systems can offer significant benefits to vessels including accurate and real-time display of vessel position relative to waterway features, voyage planning and monitoring, training tools for new personnel and integrated display of river charts, radar, and Automatic Identification Systems. Following recommendations by the National Transportation Safety Board, the National Academy of Science and the American Waterways Operators, Congress directed the Corps of Engineers to develop and publish electronic charts for the inland waterways. Development of Inland Electronic Navigational Charts (IENCs) to cover the Mississippi River and tributaries thus began in 2001 with pilot projects on the Atchafalaya River in Louisiana and Lower Mississippi River near Vicksburg, Mississippi. These projects, which involved a combination of in-house and contract activities, were the first efforts to collect and convert inland waterway data, commonly used for river and channel maintenance, into the international S-57 hydrographic data exchange. This highly structured data format is commonly used for electronic chart applications and will be used for Corps IENCs. An S-57 database is extracted into an Esri File Geodatabase for publication. This is that geodatabase and it contains 99 feature classes that make up the IENC data.</idPurp>
```

Figure 7: [A] REST endpoint page with key functionalities highlighted and [B] workflow for viewing root XML metadata online and querying data in JSON, HTML, or other formats. Example acquired from: `<http://iencccloud.us/arcgis/rest/services/IENC_Feature_Classes/ADMINISTRATIVE_AREA/MapServer>`

Refer to previous sections to compare capabilities of various types of services. The capabilities are similar except for a few enhanced and diminished functionalities:

- 1) In contrast to other access methods, a Map Service's attribute table can be analyzed and queried similar to the **Select by Attribute** function in a map viewer.
- 2) Feature Services cannot be directly exported to shapefiles or file geodatabases.
- 3) Metadata (e.g., `<https://Server/ServiceName/MapServer/info/metadata>`) displays the underlying XML structure and is not formatted as in ArcGIS Pro and ArcCatalog. All information visible in the previously mentioned software (and in some cases, additional information) is still present.



HIFLD Open

1. Navigate to HIFLD Open. Locate the desired service using the search tool, data catalog, or by browsing available categories. In this example, the USACE IENC *Administration Areas* layer will be used. A map service and KML/WMS/WFS capabilities are available for this layer.
2. Once you have navigated to the layer page, you will have several options: [A] preview visually, attribute table, or perform queries, [B] view layer summary, [C] view available attributes, [D] download a local copy in several formats, [E] access API links or [F] the REST endpoint (see previous sections for more information on how to use these in the target application), and [G] view metadata (Figure 8).

Administration Areas (USACE IENC)
Last updated 2 months ago

A

Overview Data API Explorer

3/20/2020 Feature Layer No license specified

B Download all USACE IENC layers here:
http://ienccloud.us/ienc/products/files/u37/ienc_master_dataset_gdb/USACE_IENC_Master_Service_gdb.zip
Administration Area (Named) A defined (and possibly named) administrative area. Distinction: land region; contiguous zone; continental shelf area; exclusive economic zone; fishery zone; territorial sea area;

D Download **E** APIs

About
HIFLD Open GP - Transportation: Water
Shared By: kirsten.hudson_geoplatform
Data Source: ienccloud.us
F View Metadata **G**
Create Webmap
Create a Story Map

C Attributes
Chart Map Visualization

Information	Jurisdiction	Nationality	Object_Name	Scale_Minimum	SHAPE_Area	SHAPE_Length
Text	Text	Text	Text	Number	Number	Number
Source_Dataset	Source_Date	Source_Indication	SHOW MORE 2 Attributes			
Text	Text	Text				

Figure 9: Sample image from HIFLD Open Layer page various its various key functionalities labeled.



How to Change Metadata Format

This tutorial demonstrates the process of changing the metadata format from ISO 19139 to Federal Geographic Data Committee (FGDC). This metadata is descriptive information for HIFLD Open items that are not directly linked to an external service. This metadata is distinct from metadata viewed from the REST endpoint (e.g., <https://Server/ServiceName/MapServer/info/metadata>). While new metadata is generally formatted as ISO 19139, some layers have metadata that was originally designed to be viewed as FGDC metadata such as in the example layer below: *Fortune 500 Corporate Headquarters*.

1. Select 'Display metadata' on the desired layer (Figure 8, item G).
2. Change the metadata format by modifying the URL. Locate the 'default' in the desired metadata URL and replace the text to 'fgdc' (Figure 9). Hit enter to refresh the page.

A <https://www.arcgis.com/sharing/rest/content/items/a4d813c396934fc09d0b801a0c491852/info/metadata/metadata.xml?format=default&output=html&...>

Fortune 500 Corporate Headquarters

ISO-19139 Metadata

Metadata Information:

Metadata language:
Metadata character set: utf8
Last update: 2018-06-14
Maintenance:
Update frequency: annually
Other maintenance requirements: Last metadata review date: 04/30/2018

Metadata contact - pointOfContact:
Organization's name: HIFLD Support Team

Scope of the data described by the metadata: dataset
Name of the metadata standard used: NAP - Metadata
Version of the metadata standard: 1.2

B <https://www.arcgis.com/sharing/rest/content/items/a4d813c396934fc09d0b801a0c491852/info/metadata/metadata.xml?format=fgdc&output=html&...>

Fortune 500 Corporate Headquarters

Identification Information:

Citation:
Citation Information:
Publication Date: 20180430
Title: Fortune 500 Corporate Headquarters
Edition: 63rd
Geospatial Data Presentation Form: vector digital data
Other Citation Details: Data shown are for the fiscal year ended on or before Jan. 31, 2017.
Larger Work Citation:
Citation Information:
Title: HIFLD Open and HIFLD Secure

Description:
Abstract: This database is composed of "an annual list of the 500 largest industrial corporations in the U.S., published by Fortune magazine. The corporations are ranked based on such metrics as revenues, profits, and market value", as defined by InvestorWords.com - http://www.investorwords.com/2056/Fortune_500.html The entities represented in this dataset are the companies' headquarters location only. This dataset does not include branches, divisions, annexes, or subdivisions of these company headquarters. There are no entities located in Alaska, Hawaii, Guam, Puerto Rico, American Samoa, the Northern Mariana Islands, or the Virgin Islands included in this dataset. The locations of points were geocoded to street address and are not necessarily located on-entity, unless stated otherwise. Data shown are for the fiscal year ended on or before Jan. 31, 2017.

Figure 9: [A] Default (ISO-19139) metadata and [B] augmented FGDC metadata format.

3. View metadata in FGDC format (Figure 9).